Assessment

Forest Plan Revision

Final Fire Report

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for:
Custer Gallatin National Forest

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Contents

Introduction

A draft of this report was released for public review on November 30, 2016 and feedback was requested by January 6, 2017. Changes made to the final report were to add information about the natural range of variability (the reference condition) of fire. The amount of recent (1984-2015) high, low and mixed-severity fire was compared to this reference condition as part of the assessment of ecological integrity.

Fire is a natural ecosystem driver on the landscape simply because natural ignitions sources (lightning) exist. It is a driver of change that influences vegetation structure and composition, carbon and nutrient recycling, snag and tree cavity creation, and stimulates seeding and sprouting of fire-dependent, fire-adapted vegetation. It is not simply a question of "if" an area or landscape will burn, but rather when will it burn. How will the fire behave (intensity, severity and extent)?

There are many factors that influence fire type, intensity, severity and extent, and overall fire effects. These include fuel loadings, live and dead fuel moistures, climate, weather, topography, vegetation structure and composition, elevation and seasonality. Other disturbances, such as insect infestations, can have an effect on fire behavior with changes to canopy fuel moistures, standing dead trees, and ultimately the down woody fuel conditions.

Typical fire behavior common in the ponderosa pine woodland and savanna (herein referred to as the Pine Savanna) landscapes includes low-intensity, fast-spreading surface fires, while the more mountainous landscapes experience ignitions resulting in mixed-intensity, mixed-severity fires and high intensity, large stand-replacing fires. The majority of ignitions and the largest fires occur in mid-July through late September, and are generally wind-driven events.

Wind plays an important role in the fire environment and extent of fire spread across all landscapes found on the Custer Gallatin National Forest. Fires occurring in the montane landscapes found on the central and west portions of the Custer Gallatin, generally move or spread from the southwest to the northeast direction in a somewhat lenticular fashion. The Pine Savanna landscapes located on the eastern side of the Custer Gallatin typically experience weather patterns that cause fires to spread from the northwest to the southeast or west to east depending on the prevailing wind. In all cases, fire movement is related to direction of dry cold fronts. Without the influence of wind, terrain and diurnal heating influence fire movement by causing fire to move uphill faster than downhill.

Process and Methods

Wildfire occurrence records and historical weather datasets (years 1940-2015) were gathered from the FAMWEB database and national fire occurrence databases (Short 2015). FAMWEB is the data warehouse for all Federal and State historical and current fire record data and weather station data. Using data housed in FAMWEB, statistical information (number of fires per year, fire size classes, statistical cause and average number of ignitions per day) was generated using the FireFamily Plus v.4.1 model. (from NWCG). To compare current trends to past, two sets of fire occurrence data were gathered and generated through the Fire Family Plus model. For the general discussion and to display the differences between the Pine Savanna landscapes versus the Montane-mountainous landscapes, fire occurrence and historical weather data sets from 1965 to 2015 were used. To capture the current effects of a warmer, drier Pacific Decadal Oscillation climate cycle, fire occurrence and weather data more specific to the five individual landscapes, current picture of the past 30 years (1985-2015) was used.

Fire regime combines fire frequency, severity and extent (Anderson 1982). It is assessed at the context, plan and local scales. For the forest plan assessment, fire severity is discussed at the context scale and plan scales, since burn severity data is limited or unavailable for all fires that have occurred on the Custer Gallatin National Forest. Fire regime information was derived from LANDFIRE 2010 imagery v. 1.2.0 (www.landfire.gov) and based on the coarse-scale definitions developed by Hardy and others (2000, 2001). LANDFIRE is currently the best imagery source, used in all wildland fire planning and fuel management planning because it provides seamless data coverage across all land ownerships.

Scale

The Custer Gallatin National Forest provides fire and fuels management on approximately 3.1 million acres of National Forest System lands located in south central and eastern Montana, and the northwest corner of South Dakota. For the purposes of the forest plan assessment, the fire and fuels management assessment will be discussed for five geographic landscapes representing the Pine Savanna (ponderosa pine woodland and savanna) and Montane (mountainous) ecosystems. The ponderosa pine woodland and savanna landscapes found on the Ashland and Sioux district are discussed as the pine savanna ecosystems. The more mountainous, forested landscapes of the Madison-Henrys-Gallatin and Absaroka-Beartooth mountain ranges, the Bridger-Bangtail-Crazy mountain ranges, and Pryor Mountains make up the Montane ecosystems. (Table 1)

Table 1. Distribution of National Forest System acres found in each ecological landscape across the Custer Gallatin National Forest

Landscape	National Forest System Acres within Custer Gallatin National Forest [1]
Pine savanna - Ponderosa pine woodland & savanna	600,584
Montane – Mountainous landscapes	2,438,732

1. Custer Gallatin GIS, land ownership records

Existing Information Sources

Forest Service policy and direction that are relevant to this plan include:

- Fire Management Amendment to the Gallatin Forest Plan Decision Notice (2011)
- Gallatin National Forest Plan (1987)
- Custer National Forest Plan (1986)
- Forest Service Manual (FSM) 5100
- Forest Service Handbook (FSH) 5109
- Forest Land Assistance, Management, and Enhancement Act (FLAME) 2010
- Update on the Modifications to the Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy: Memorandum NWCG 001-2009
- Guidance for Implementation of Federal Wildland Fire Management Policy (February 13, 2009)
- Foundational Doctrine and Guiding principles for the Northern Region; Fire, Aviation and Air Program (2007)
- Review and Update of the 1995 Federal Wildland Fire Management Policy (2001)

- Managing Impacts of Wildfires on Communities and the Environment (September 2000) – *aka National Fire Plan*
- Protecting People and Sustaining Resources in Fire Adapted Ecosystems – A Cohesive Strategy (October 2000)
- A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Comprehensive Strategy Implementation Plan (May 2002)
- Greater Yellowstone Area Interagency Fire Management Planning and Coordination Guide (May 2011)
- List of Best Available Science Reference Citations included at the end of the "Drivers & Stressors: Fire" Report.

Database and models used for this assessment topic:

- Landfire 2010, v. 1.2.0 datasets, www.landfire.gov
- FireFamily Plus v. 4.1, NWCG – Model which combines historic fire data and weather data to generate statistical information such as fire activity trends, seasonality changes.
- Large fire polygon records - Custer Gallatin NF GIS spatial data
- Historical Fire Occurrence records (1940-2015) – derived from FIRESTAT and the National Fire History data warehouse (Short 2015)
- Fire ignition point data – Custer Gallatin National Forest FIRESTAT data records, NWCG
- Monitoring Trends in Burn Severity, fire severity data for fires larger than 1000 acres www.mtbs.gov

Current Forest Plan Direction

Gallatin Forest Plan (1987) – Fire Management Amendment (2011)

The original 1987 Gallatin National Forest Plan direction for fire management reflected national fire management policies in place at the time it was published. In 2006, the national forest staff decided to update the 1987 forest plan direction for fire management for several reasons: the recent changes in national fire management policies; recent updates to other neighboring Federal land management agencies' fire management directions; recognition of the role of wildland fire as an essential ecological process and natural change agent on the landscape; the increased fire activity in recent years; and to provide opportunities to reduce costs associated with wildland fire management by not implementing full fire perimeter control tactics where it is not needed.

In 2011, all fire management standards specific to each management area were evaluated and the 1987 forest plan direction amended to include the following forestwide standard: One or more fire management strategies may be considered and implemented for any unplanned wildland fire to achieve a variety of resource management objectives, while minimizing negative effects to life, investments and valuable resources.

The Fire Management Amendment also adopted the direction for using planned, prescribed fire to achieve resource objectives throughout all management areas as provided in the 1987 forest plan, with the exception of Management Area 4 (designated and recommended wilderness areas). The Amendment revised the fire management standards for the management areas representing designated and recommended wilderness (MA 4), by formally incorporating the Forest Service Handbook 2324 direction on managing fire and fuel conditions within wilderness areas as follows:

Wildland Fire

- Permit fire to play, as nearly as possible, its natural ecological role on the landscape.
- Reduce, to an acceptable level, the risks and consequences of wildland fire within wilderness or escaping from wilderness.
- Allow fire to move into and out of wilderness boundaries as necessary based on the historic burning patterns, ecological health, impacts to abiotic and biotic components of the wilderness.

Fuel Treatments

- Planned ignition and/or mechanical fuel manipulations outside of wilderness boundaries.
- Planned ignitions outside of wilderness boundaries that burn into wilderness where wilderness management objectives and conditions are met.
- Planned ignitions inside of wilderness boundaries that burn out of the boundary where wilderness management objectives and conditions are met.
- Planned ignitions within the wilderness boundary where wilderness management objectives and conditions are met.

Custer National Forest (1986)

The Custer National Forest Land and Resources Management Plan (USDA Forest Service 1986) provides the following direction for fire and fuels management.

Forestwide Goals

The goal of air resource management is to meet or exceed State air quality standards and ensure protection of air quality related values (Custer forest plan, p. 4).

The management of the Custer National Forest ensures a safe and legal environment for public use, as well as for cost-efficient fire protection and fuels management program that is responsive to the goals of the Forest, including cooperative efforts with other agencies and organizations.

Forestwide Objectives

Air quality of the National Forest System Lands will be maintained at or above levels required by Federal and State laws, regulations, and standards. The Forest Service will work with State and other Federal agencies to assure these standards are met (Custer forest plan, p. 5).

Forestwide Standards

Cooperating with Montana, North Dakota, and South Dakota Air Quality Bureaus in the Prevention of Significant Deterioration program and will protect air quality (Custer forest plan, pp. 21-39). Requirements of the Prevention of Significant Deterioration program, state implementation plans, and State of Montana, North Dakota, and South Dakota smoke management plans will be met whenever the Forest Service has the authority to do what is requires. The Custer Gallatin National Forest will cooperate with states, other agencies, and organizations in identifying, evaluating, proposing solutions, and monitoring air quality problems associated with activities permitted on National Forests and National Grasslands (Custer forest plan, p. 26).

A combination of treatments will be used that will most efficiently meets the fuels management direction of each management area. The Custer Gallatin will consider the use of prescribed fire, using both planned and unplanned ignition as a management tool. Unplanned ignitions may be used throughout the Forest to meet management area goals when proper fire prescriptions have been developed and approved by the Forest Supervisor. When prescribed fire-planned ignition is part of the treatment, it will be carried out at a time and within a prescription that will minimize impacts on air quality and soil damage, achieve the desired results, and conform to the Northern Region Fuel Management and Treatment Guidelines (Custer forest plan, p. 39).

Existing Condition

The influence of fire is evident across the diverse landscapes of the Custer Gallatin National Forest planning area and one of the important drivers of ecosystem characteristics and function. Fire occurrence, and the type and frequency of fire (referred to as natural fire regimes) varies depending on whether ignitions start in dense forested environments or open grassland savannahs. For the Pine Savanna landscapes of Ashland and Sioux Districts, fires generally burn with low, non-lethal intensity and severity and high rates of spread (Fisher and Clayton 1983; Arno and Gruell 1986; Keane and others 2004; Sneed 2005). Fire burning in the Montane areas of the Pryors, Madison-Gallatin-Henrys and Absaroka-Beartooth, and the Bridger-Bangtail-Crazies landscape areas may also burn as a low intensity, surface fire, however mixed severity and stand-replacing fires are more typical, and fire return intervals, on average, are longer.

Fire regime represents the periodicity and pattern of naturally occurring fires, described in terms of frequency, biological severity and aerial extent (Anderson 1982). Barrett and others (2010) classified natural fire regimes based on the average number of years between fires (fire frequency or mean fire return interval) combined with severity (the amount of surface vegetation replacement), and its effects to the dominant vegetation. Detailed description of fire regimes is provided in the “glossary” section attached at the end of this document. The fire regimes across all landscapes on the Custer Gallatin were determined using LANDFIRE data (Landfire 2010, v. 1.2.0) and provided in Table 2, and by cover type in Table 3.

Table 2. Fire regimes, vegetation types, and acres and percent distribution on the Custer Gallatin National Forest (Landfire 2010, v.1.2.0)

Fire Regime[1]	Definition[1]	Existing Vegetation Types[1,2]	National Forest System Acres[3]	Percent of Landscapes
I	0- to 35-year frequency; non-lethal, low / mixed severity	Mountain sagebrush; Ponderosa pine; dry Douglas-fir; deciduous woodland draws/ravines	216,324 - Pine savanna 124,847 - Montane	32% - Pine savanna 4% - Montane
II	0- to 35-year frequency; replacement (high severity)	Grasslands; mixed grass pine savannas; Great Plains shrublands	387,267 - Pine savanna 43,070 - Montane	57% - Pine savanna 1% - Montane
III	35- to 200-year frequency; mixed / low severity	Wyoming big sagebrush; low sagebrush; riparian systems (cottonwood); limber pine / Rocky Mountain juniper; dry lodgepole pine; moist Douglas-fir; whitebark pine	34,288 - Pine savanna 973,770 - Montane	5% - Pine savanna 34% - Montane

Fire Regime[1]	Definition[1]	Existing Vegetation Types[1,2]	National Forest System Acres[3]	Percent of Landscapes
IV	35- to 200-year frequency; replacement (high severity)	Aspen; moist lodgepole pine; subalpine fire, Engelmann spruce	38,660 - Pine savanna 251,146 - Montane	5% - Pine savanna 9% - Montane
V	Greater than 200-year frequency; any severity	Poor-site lodgepole pine; subalpine forbs and grasses; whitebark pine	0 - Pine savanna 1,105,911 - Montane	0 – Pine savanna 40% - Montane
Sparsely Vegetated	National Land Cover database (NLCD) class	N/A	1,579 - Pine savanna 170,718 - Montane	> 1% - Pine savanna 6% - Montane
Barren	NLCD Class	N/A	2,019 - Pine savanna 72,135 - Montane	> 1% - Pine savanna 3% - Montane
Snow/Ice	NLCD class	N/A	0 - Pine savanna 7,226 - Montane	0 – Pine savanna > 1% - Montane
Water	NLCD class	N/A	114 - Pine savanna 24,420 - Montane	> 1% - Both

1. Table information is adapted from Barrett and others 2010.
2. Vegetation types are not the same as existing vegetation types discussed elsewhere in this chapter.
3. Acre summaries in this section may differ slightly due to the data source (raster data versus vector GIS data)

All fire regimes are present across on the Custer Gallatin National Forest. The representative acres of each fire regimes for the five assessment landscapes are provided in Table 3.

Table 3. Fire regime acres by landscape (Landfire 2010, v.1.2.0)

Fire Regime	Ashland (Pine Savanna)	Sioux (Pine Savanna)	Bridger-Bangtail-Crazies (Montane)	Madison-Gallatin-Absaroka Beartooth (Montane)	Pryors (Montane)
I	169,128	47,196	100,715	1,129	23,002
II	267,069	120,198	15,344	13,036	14,689
III	26,068	8,221	58,512	881,093	4,164
IV	38,314	386	101,299	115,335	34,511
V	0	0	7,583	1,096,862	1,466

Acres based on CGF spatial data and Landfire 2010, v. 1.2.0

The predominant fire regimes of the Pine Savanna habitats found on the Ashland and Sioux Districts, fall into fire regimes I and II. The mountainous landscapes found on the Custer Gallatin, comprised of predominately forested and high alpine vegetation, have longer mean fire intervals and fall into fire regimes III, IV and V (Table 4).

Low severity fires are common in low elevation dry forests found in all landscapes across the Custer Gallatin, which generally result in minimal overstory canopy mortality, edge and patch size (Arno and others 2000; Hessburg and others 2005; Custer Gallatin National Forest burn severity data 2001, 2003, 2006, 2012). These fires move through an area often consuming litter, herbaceous fuels and foliage with little heat transfer down through the duff (Fischer and Clayton 1983). Forest types adaptable to frequent, non-lethal, low severity fire were dominated by fire-resistant, early seral species. These fires also maintained grassland, shrubland and open forest/grassland habitats. This type of fire would be common in fire regimes I, II and III.

Table 4. Proportion of fire regime for each cover types by landscape area (LandfireR1 Summary Database, FIA plots)

Cover Type (dominant)	Fire Regime	Pine Savanna Landscapes (%)	Montane Mountainous Landscapes (%)
Non-forest (grass, shrub)	II	70	32
Ponderosa pine	I, II	29	3
Aspen/hardwoods	IV	1	1
Spruce/subalpine fir	IV	0	20
Lodgepole pine	III, IV	0	19
Mixed conifer (Douglas-fir, lodgepole pine, spruce, subalpine fir)	III	0	13
Whitebark pine	IV, V	0	9
Dry Douglas-fir	I	0	3

Mixed severity fires kill a proportion of the overstory, burning in a mosaic of severities (Barrett and others 2010). Overstory mortality from such fire can be from 20 to 70 percent (Hessburg and others 2005; Custer Gallatin National Forest burn severity records 2001, 2003, 2006, 2012). Mixed severity fire typically creates variable patch sizes and abundant edge, thorough a mosaic of effects including stand-replacement, low severity and unburned areas (Arno and others 2000). This type of fire would also be common in the Montane landscapes in habitats with fire regimes I, III and IV.

Stand-replacing fire is considered high severity fire, where most tree cover over a substantial amount of area (greater than 70 percent), is killed, returning the forest to early successional stages (Barrett and others, 2010; Custer Gallatin National Forest burn severity records 2001, 2003, 2006, 2012). Due to the size and extent, this type of fire may create an intermediate amount of edge compared to a mixed-severity fire (Arno and others 2000). This type of fire is most common in fire regimes IV and V, which predominately is found in the montane landscapes located in the central and western portions of the national forest.

Landscape Areas

Pine Savanna Landscapes

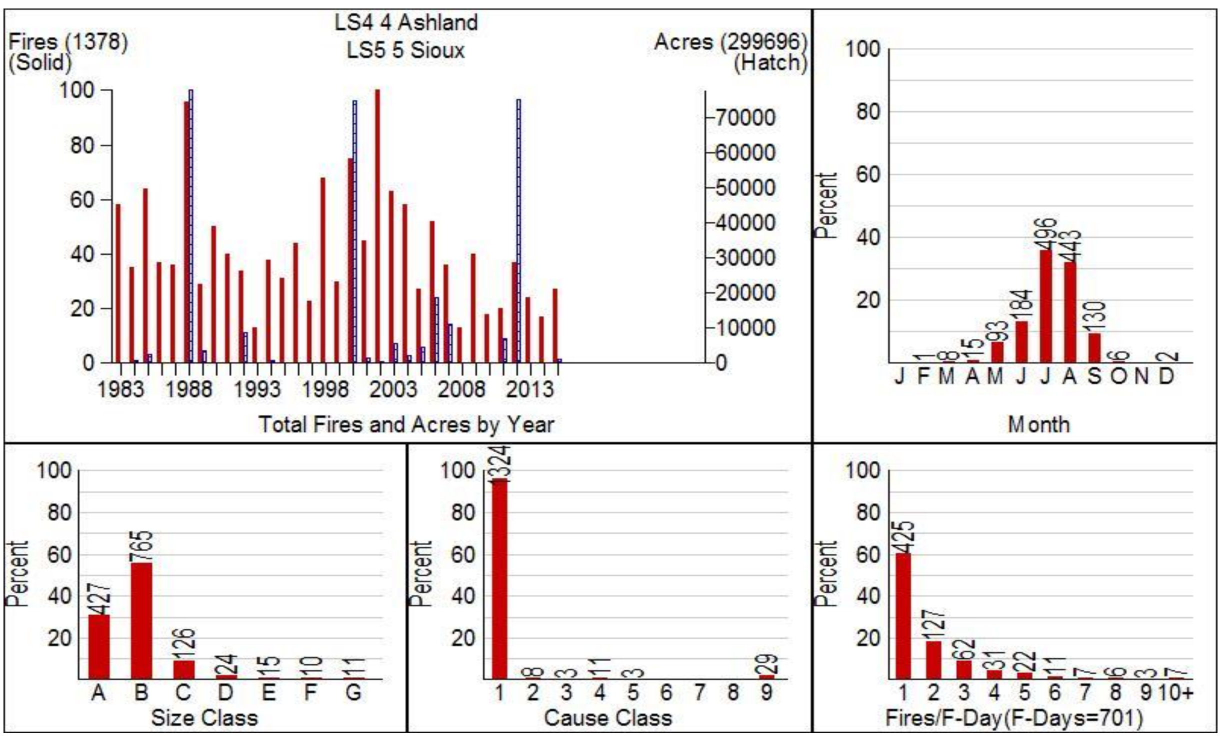
Approximately 600,584 acres of National Forest System lands are grouped under the Pine Savanna landscapes of the Ashland and Sioux Districts. The topography ranges in elevation from 3,000 to 4,400 feet. Steeper slopes of 40 to 60 percent are usually short with only 500 feet in elevation difference. Numerous east-west drainages break up the landscape on the Ashland District into large homogenous compartments. On the Sioux District, the landscape is widely separated into eight distinct “land units.”

Different from the mountainous landscapes found on the Custer Gallatin National Forest, the prevailing winds that influence fire spread and general fire movement in the Pine Savannah landscapes originate from the northwest, causing fire movement to the southeast direction. During some extreme weather events, the Ashland and Sioux District landscapes can experience high, hot and dry winds originating from the easterly direction, which can cause unpredictable fire behavior situations and rapid fire movement. As with the Montane landscapes, strong winds are associated with cold fronts and thunderstorms, resulting in erratic shifts in wind direction and strong downdraft wind activity. Wind gusts in excess of 40 miles per hour are not uncommon with cold fronts and thunderstorms in this area.

Recent successive years of snow damage across these open landscapes have created areas of heavy down, woody fuel conditions, especially on the Sioux District. The fuel profile has been substantially altered in some of these areas. Historically, wind has been a significant factor in large fire growth in these landscapes. Add in the uncharacteristic fuel loads due to storm damage and the stage is set for an established fire to exhibit very intense to extreme fire behavior.

Another naturally occurring environmental feature on these landscapes are exposed coal seams. Coal is naturally occurring and located in rock strata in layers or veins called coal beds or coal seams. Exposed coal seams are abundant through southeast and central Montana as well as western North Dakota and South Dakota. Once a coal seam is ignited, it can burn for weeks if not years both above and below ground level. These fires pose a serious problem that can be a hazard to firefighter's health and safety. Coal seam fires can emit toxic gases, including carbon monoxide, sulfur dioxide, and other potentially hazardous gases.

From available historic and recent fire records, Figure 1 provides information on fire occurrence within the Pine Savanna landscapes of Ashland and Sioux Districts since the 1940s. Almost 95 percent of recorded fire ignitions are by lightning.



Size Classes (Acres): A=0-0.25, B=0.26-9.9, C=10.0-99.9, D=100-299, E=300-999, F=1000-4999, G= >5000
Cause Classes: 1=lightning, 2= equipment, 3=smoking, 4=campfire, 5=debris burning, 6=railroad, 7=arson, 8=children
Fires/F-Day = equates to number of starts per day. 1= one start in a day, 2= 2 starts in a day, etc.

Figure 1. Wildfires 1940-2015, Pine Savanna landscapes

Ashland District

The average number of fires that have occurred from 1985 to 2015 across the varied landscapes of the Ashland District is approximately 35 fires per year. Grass and shrubland vegetation are the primarily carriers of fire in these landscape, and when accompanied by strong wind events as witness in 2012, can experience large fire growth. Lightning is the cause for 96 percent of ignitions (cause class 1), with upwards of 60 percent of fires less than 10 acres in size. Years when fire burned large acreage in this landscape include 1988, 2000, 2006 and 2012. The 2012 Ash Creek Fire was one of the largest fires east of the Continental Divide over the past 30 years, affecting 249,562 acres of national forest, tribal, and private land.

Sioux District

The average number of fires that have occurred from 1985 to 2015 across the island landscapes of the Sioux District is approximately eight fires per year. Similar to the Ashland District, grass and shrubland vegetation are the primarily carriers of fire in these landscape. Strong wind events are common throughout all months of the year. Lightning is the cause for 96 percent of ignitions (cause class 1), with the majority of fires are less than 10 acres in size. Large fire acre years include 1988 and 2012.

Montane Landscapes

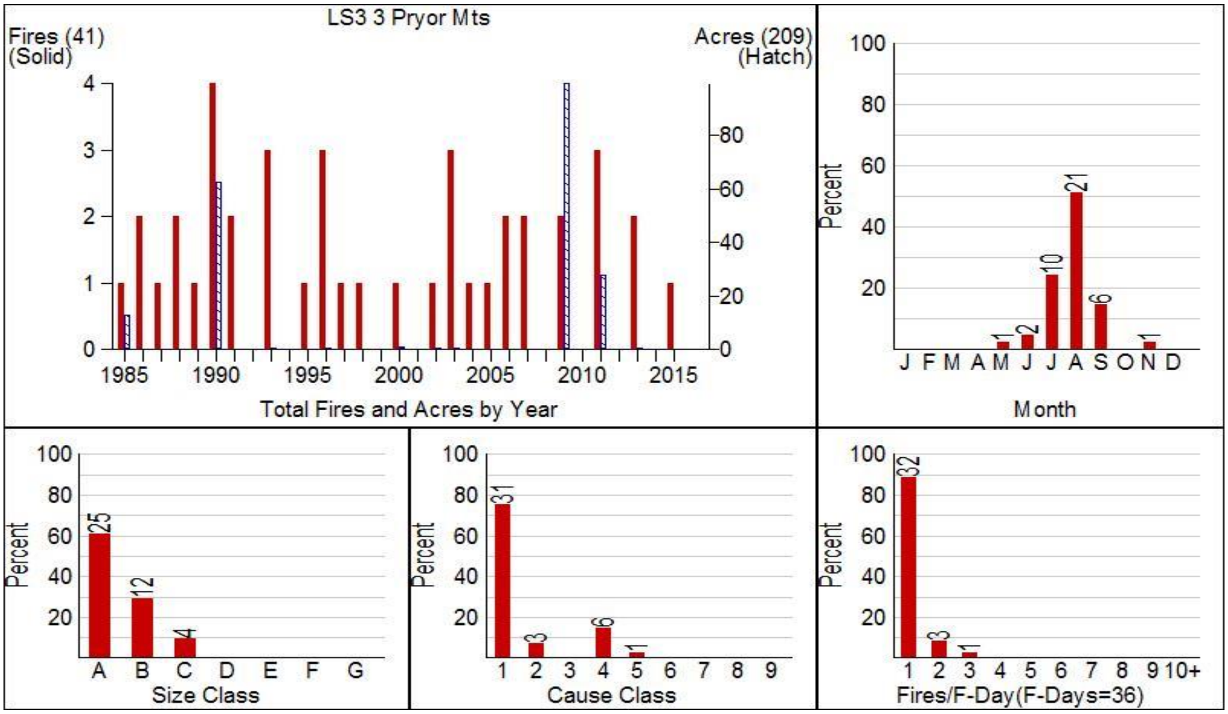
Approximately 2,438,732 acres of National Forest System lands are grouped under the Montane landscapes of the central and western portions of the Custer Gallatin National Forest. The prevailing winds that influence fire spread and general fire movement in the mountainous landscapes of the Custer Gallatin originate from the southwest, pushing fire movement in the northeasterly direction. During extreme weather events, the montane landscapes experience high, hot and dry winds originating from the easterly direction, which can cause unpredictable fire behavior situations. Strong winds are associated with cold fronts and thunderstorms, resulting in drastic, erratic shifts in wind direction and strong downdraft wind activity. Winds gust in excess of 40-70 mph are not uncommon with cold fronts and thunderstorms in this area.

There are substantial differences in the number of fire ignitions and how fire may be managed in the larger mountain ranges that make up the montane landscapes. For these reasons, the assessment discussion will analyze fire history and regimes separately for the Pryor Mountains, Madison-Henrys-Gallatin ranges and Absaroka Beartooth ranges. To better depict the uniqueness of fire occurrence across the various Montane landscapes, Figure 2 through Figure 5, provide information on fire occurrence. Almost 70 percent of recorded fire ignitions are by lightning.

Pryor Mountains

Continuous stands of lodgepole pine, ponderosa pine, Douglas fir and/or subalpine fir occur throughout the Pryor Mountain range, intermingled with open grassland parks. When dry, windy weather and dry fuel moisture conditions are reached, there is a high potential for stand-replacing fire events due primarily to the contiguous dense tree canopies. The historic fire regime for the Pryor Mountain landscape is Group III (fire frequency of 35-100+ years; mixed severity and/or surface wildfire), and fire regime condition class II, meaning the vegetative habitats have skipped at least one fire occurrence cycle. Management of wildland fire in the Pryors is challenged by the close proximity to high valued resource such as areas in close proximity to private lands and cultural sites. (Figure 2).

The average number of fires that have occurred in the Pryor Mountains, is approximately four fires per year. Lightning is the cause for 77 percent of ignitions (cause class 1); and roughly 60 percent of fires are less than 10 acres in size.



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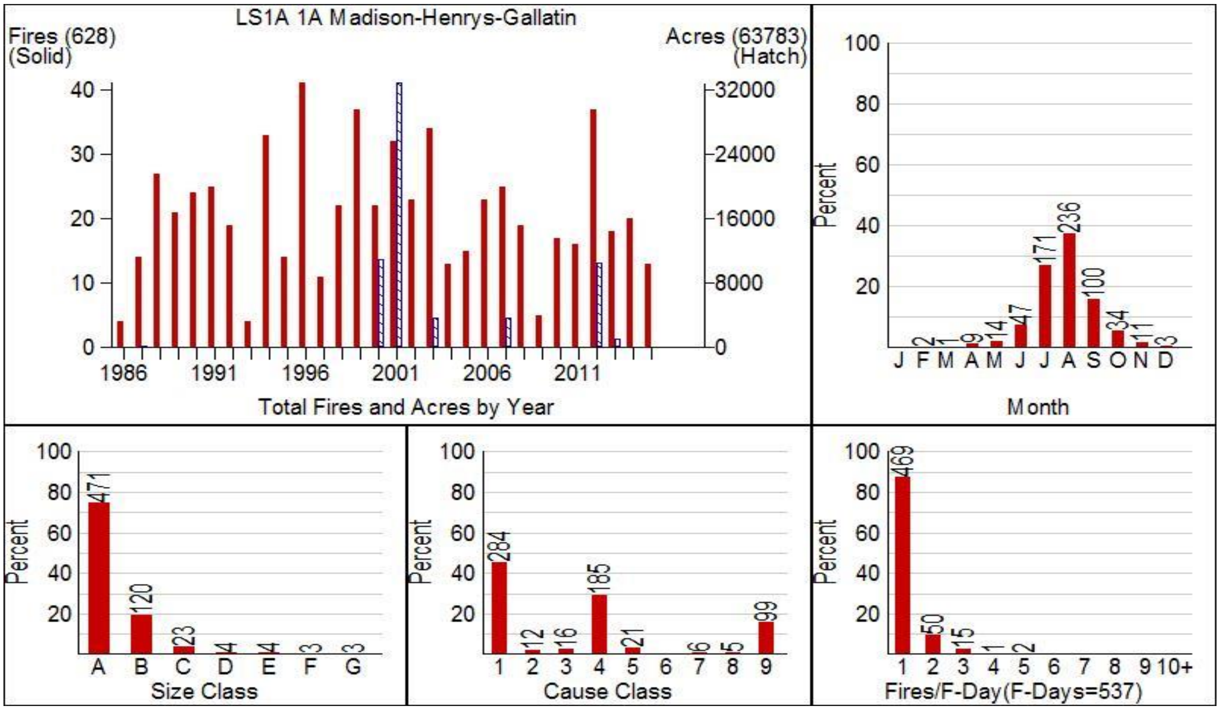
Fires/F-Day = equates to number of starts per day. 1= one start in a day, 2= 2 starts in a day, etc.

Figure 2. Wildfires 1985-2015, Pryor Mountains

Madison-Henrys-Gallatin-Absaroka Beartooth Mountain Ranges

The Madison-Henrys-Gallatin ranges are long, slender mountain ranges oriented in the south-southwest to north-northeasterly direction, when compared to the larger Absaroka-Beartooth ranges. As illustrated in Figure 3, the average number of fires that have occurred from 1985 to 2015 in the Madison, Henrys, and Gallatin mountain ranges is approximately 21 fires per year. The topographic characteristics and orientation of large drainages within these landscapes favor large fire growth if accompanied by significant wind events. Wildland-urban interface and major travel corridors are some of the high valued resources that surround and intersect these three large landscapes, limiting the use of fire to achieve ecosystem management goals. As such, fires ignited in these landscapes tend to be aggressively suppressed since in the last 30 years. Lightning is the cause for 46 percent of ignitions (cause class 1); 30 percent by escape or abandoned campfires; and 19 percent by humans. Seventy-five percent of fires are less than 0.1 acre in size. Large fire years include 2000, 2001, 2003, 2007 and 2012, with the majority occurring in the Gallatin Mountain Range.



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Fires/F-Day = equates to number of starts per day. 1= one start in a day, 2= 2 starts in a day, etc.

Figure 3. Wildfires 1985-2015, Madison-Henrys-Gallatin mountain ranges

When compared to the Madison-Henrys-Gallatin ranges, the average number of fires that have occurred during the same analysis time period in the Absaroka-Beartooth Mountains, is approximately 15 fires per year. (Figure 4). Approximately 70 percent of these mountain ranges are managed as designated wilderness. The topographic characteristics and orientation of large drainages within these landscapes favor large fire growth if accompanied by significant wind events. Lightning is the cause for 58 percent of ignitions (cause class 1); and roughly 70 percent of fires are less than 10 acre in size. Years where fire affected large acres in this landscape include 1988, 1996, 2006 and 2007.

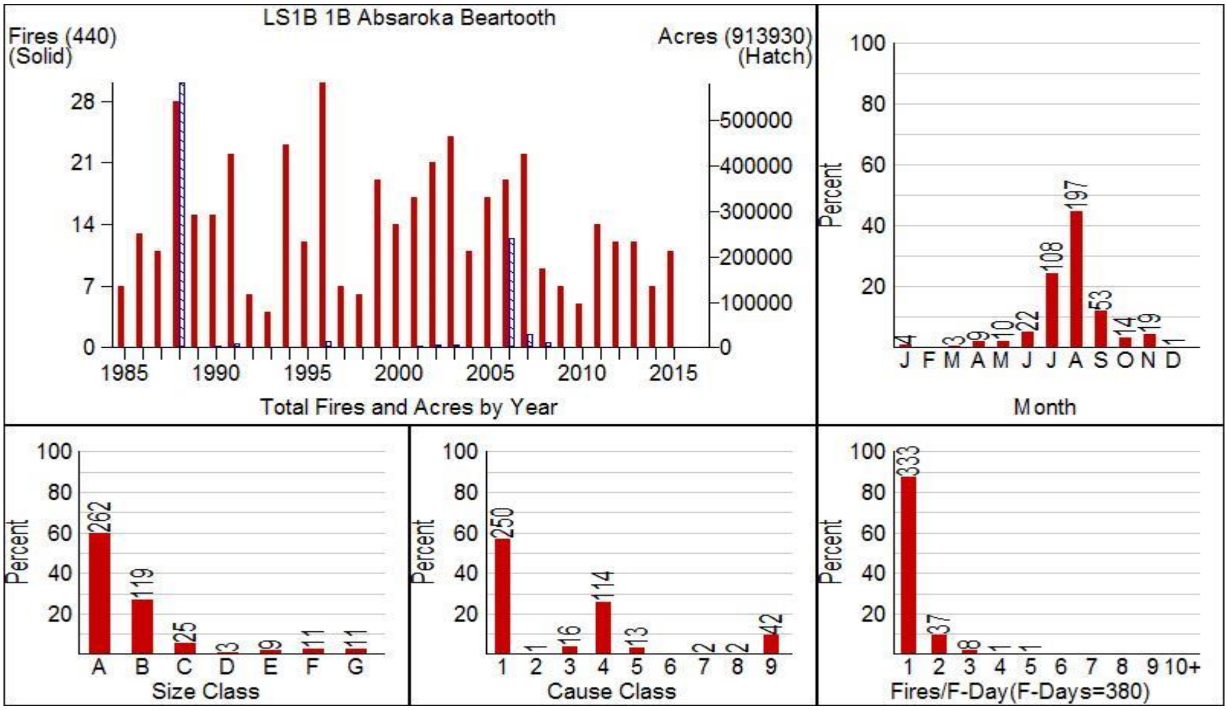

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Figure 4. Wildfires 1985-2015, Absaroka-Beartooth mountain ranges

Bridger, Bangtail, and Crazy Mountain Ranges

The average number of fires that have occurred from 1985 to 2015 in the Bridger, Bangtail and Crazy mountain ranges is approximately four fires per year (Figure 5). While this seems a low number, the topographic characteristics where a large percent of these landscapes lack substantial vegetation (e.g., rocky peaks, scree and cliffs), and orientation of large drainages within these landscapes favor large fire growth if accompanied by significant wind events. Years when fires burned large acreage in these landscapes include 1991, 2000 and 2003. Lightning is the cause for 70 percent of ignitions (cause class 1), with the majority of fires less than 10 acres in size.

The historic fire regime is Group V and IV (fire frequency of 35-100+ years; mixed severity and stand-replacing wildfire) with a fire regime condition class of I (within natural historic fire regime).

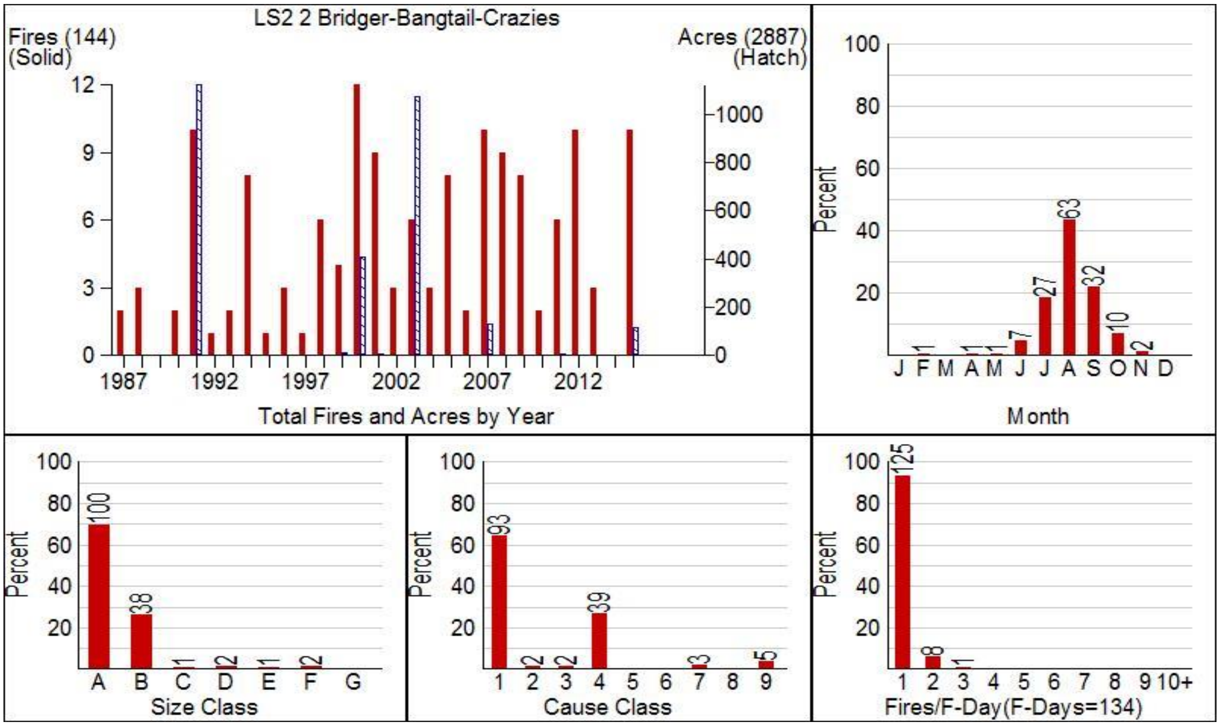

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Figure 5. Wildfires 1985-2015, Bridger-Bangtail-Crazy mountain ranges

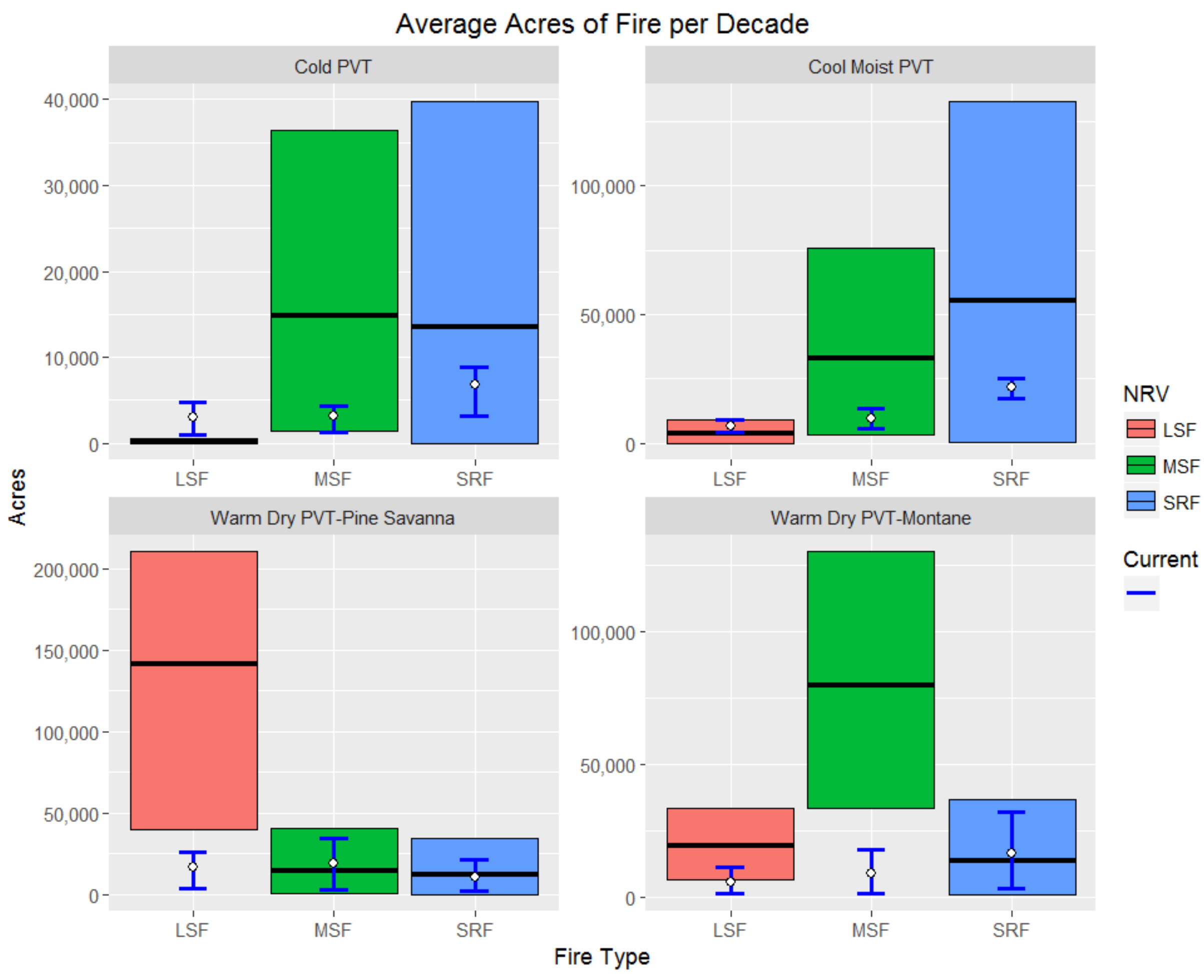
Historic Fire – Areas Burned prior to 1940

Fire history data prior to the 1940s was found in historic Forest Reserve reports, news articles, journals and fire history reports. Few, however, speak to numbers of acres affected by fire. Highlights from available sources include:

- During 1723 and 1930, 24 fires were recorded by fire scars, with 9- to 11-year intervals in the Gallatin Range and east side of the Absaroka Range, in the Deer Creek area. Mixed-severity fires were most common fire type. The fire of 1845 was probably the last large fire to impact the Storm Castle drainage, and a fire in 1815 the largest for the Deer Creeks area (Losensky 1993a, 1993b). These reports discuss historic fire sizes.
- Fire scar studies indicate between 1579 and 1930, the Crazy Mountains experience fire every 23 years, with major fires occurring in 1863, 1855 and 1849. Most fires in the lodgepole pine component were stand-replacing events. Fires that burned large portions of the west side of the Crazies were common events (Losensky 1993c). These reports do not discuss historic fire sizes.
- Active fire suppression has been ongoing on the Ashland Ranger District since the late 1800s (USDA Forest Service 2010), and much more aggressively after the 1910 fire season.
- Over half of the Gallatin River corridor (estimated 40 miles each side of the river) burned within a 4- to 5-day period in 1881 (Walter Cooper diary, August 1881).
- West and East Short Pine landscapes were burned over in 1905 (Sevling 1921).

- Forest fires burned over a stretch of ground 10 miles long, 22 miles wide, covering over 10,000 acres in the Long Pines National Forest (now Sioux District) in 1908 (Sevling 1921).
- Preston mentions in his memoir about his early days with the Forest Service, managing a large fire in the west fork of Rock Creek, near Red Lodge, MT: ". . . in a few hours we had fire from the creek to the top of the mountain."

The natural range of variability describes the historic, or reference, condition and is a tool for assessing ecological integrity. Determining the natural range of variability for vegetation components utilizes an analysis using the Simulating Patterns and Processes at Landscape Scales system (SIMPPLLE) (Chew et al. 2012). A SIMPPLLE analysis was completed to model vegetation 1,000 years into the past, and results are available in the Forested Terrestrial Vegetation assessment report (Sandbak, 2017). This analysis also provided estimates of historic fire by depicting the percentage of forested habitats that would burn in a decade, by severity, for fires over 1000 acres (Figure 6). This was achieved by comparing the modeled fire severity to the actual fire severity of fires from the past 30 years, using data from the Monitoring Trends in Burn Severity (MTBS) website (www.mtbs.gov). The forested habitats were broken down into broad potential vegetation types: cold, cool moist, warm dry - pine savanna and warm dry - montane (Milburn at al. 2015).



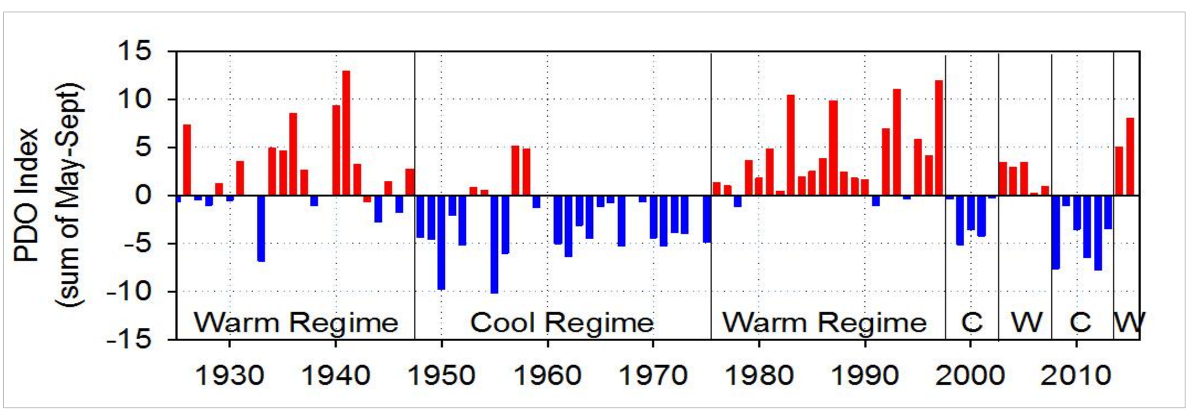
Current fire data is from MTBS (the past 30 years). NRV (Natural Range of Variability) data is modeled from SIMPPLLE. LSF = low severity fire. MSF = mixed severity fire. SRF = stand replacing (high severity) fire.

Figure 6. Average Acres of Fire per Decade (90% range of variability)

For the majority of forest types and fire severities, actual acres burned are within the lower range of the natural range of variability (NRV). This indicates that while fires are burning within their natural range of variability, the acres burned are well below average. The cold and cool-moist forest types are where the predominant historic fire severity are both mixed and stand replacing In these forest types, there is an appropriate ratio between the severities, indicating that fire has been burning in these forest types at expected severity ratios but well below average in acres burned. In the warm dry - pine savanna forest type, mixed and stand replacing fire are within the natural range of variability, but low severity fire is severely lacking. The current ratios show that all fires have an equal share of severities when, in fact, there should be more low severity fire present. In the warm dry - montane forest type, mixed severity fire should be the dominant severity, but it is below the natural range of variability. Currently, stand replacing fire is the dominant severity in this forest type. See Figure 6.

Effects of Pacific Decadal Oscillation

Forests have been affected by climate, weather and disturbance in a temporal context. Over the past century, the occurrence of wildfires has varied greatly. After the wildfires of the early 1900s and the development of the Forest Service as an effective firefighting force, a common misconception was that fire suppression was responsible for the fuel build up in forested environments, to the point where fires became more frequent, affected larger acreage and more uncontrollable over the recent decades. However, an analysis of climatic patterns over this time period has shown another significant influence: a cyclic phenomenon called the Pacific Decadal Oscillation. Similar to El Niño and La Niña, this weather trend is related to oceanic temperatures in the northern Pacific Ocean. Fluctuation in the last decade is illustrated below as well. (Figure 7). During a period between 1940 until 1980, the Pacific Decadal Oscillation was in the cool wet phase, which would have limited wildfires while at the same time promoted tree growth, regeneration and significant increases in forest density. Pacific Decadal Oscillation conditions may also be a contributing factor in the fluctuation and impacts of insect populations. For example, an increase in mountain pine beetle in the Northern Rockies, including three mountain pine beetle outbreaks in the last 100 years, all have occurred during the warm phase of the Pacific Decadal Oscillation. The recent outbreak that affected pine forest environments on the Helena Lewis and Clark and Beaverhead-Deerlodge National Forests is within the spatial footprint of millions of acres of young forests being created by disturbance factors around the turn of the century 1880-1930 (USDA Forest Service 2013).



Values are summed over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. Note that 2008 and 2012 were the most negative values recorded since 1956.

Figure 7. Time series of shifts in sign of the Pacific Decadal Oscillation (PDO), 1925 to present (NOAA 2014)

Trends and Drivers

Departure from Historical Conditions

A variety of information sources indicate that wildfire area burned has diminished relative to the historical condition across the Northern Rockies and Great Plains, although more large fires have been occurring in recent decades. Since European settlement, changes to historic fire regimes have occurred due to fire suppression, forest management, rangeland management and climate change (Fischer and Clayton 1983: Hessburg and Agee 2003; Hessburg et al. 2005; Westerling et al. 2006). Furthermore, road access, railroads, grazing, urbanization, agriculture, and rural settlement all influenced fire exclusion (Hessburg et al. 2005). Grazing was one of the earliest and most extensive land uses throughout the Ashland and Sioux landscapes, which reduced fine fuel loads and contributed to fire exclusion (Sneed 2005).

Climate, along with weather conditions, fuel moisture conditions and ignition sources, greatly influence wildfire activity (Littell et al. 2009; Keane and others 2006; Arno and others 2000). An apparent divergence in fire and climate since the mid-1800s has created a fire deficit in the West that is jointly attributable to human activities and climate change (Marlon et al. 2012).

The consequences of a departure from historical wildfire regimes on the Custer Gallatin National Forest include but are not limited to the following:

- Fire in dry forest/grassland habitats, often dominated by ponderosa pine, limber pine, and/or Douglas-fir, has shifted from low/moderate severity, high frequency to moderate/high severity regimes, with increases in uncharacteristic large-scale, stand-replacing fires (Lehmkuhl and others 2007). Because fires have been excluded in some areas, fuels have often built up to an uncharacteristic level. In some cases, numerous fire cycles have been missed.
- Higher elevation moist forests, which are often dominated by lodgepole pine and subalpine fir, naturally have a long fire interval with higher severity fires (Fischer and Clayton 1983; Arno and others 2000). Changes to the natural fire regime are less pronounced than in frequent interval fire regimes. However, while infrequent stand-replacing fires play a definite role, the interval between fires in one area might be only a few years. Fire suppression has had the effect of decreasing acreage burned in normal fire seasons, reducing natural variability in landscape patterns (USDA Forest Service 1990). While fire suppression may not have had a substantial effect on succession at the stand level due to naturally long return intervals, at the landscape scale it may have induced homogeneity (Barrett 1993).
- Fire exclusion has reduced stand and landscape diversity in lodgepole pine and subalpine forests. Vegetation has aged more uniformly and become less diverse spatially and compositionally, resulting in stand-replacing fires that regenerate extensive areas that were often a mosaic of varying age classes historically (Barrett 1997; Keane and others 2001). While the adaptation of lodgepole pine to stand-replacing events has long been acknowledged, some lodgepole forests also historically burned in low to mixed severity fire, often creating two-aged stands and variable landscape patterns (Hardy and others 2000).
- There are more instances of fires burning for extended periods of time since the mid-1980s (Westerling and others 2006). This may be attributed to vegetation conditions and a trend of warmer, drier climate regime. Vegetation changes include higher tree density, more multi-storied stands and ladder fuels, and a greater homogeneity of structures across the landscape

which results in a greater probability for disturbances to affect large contiguous areas (Hessburg and others 2005).

- Non-forested regimes have also changed, in part due to conifer encroachment that has occurred because of less frequent fire, increased livestock grazing, and climate (Heyerdahl 2006). In areas that historically had a mosaic of grasslands and shrubland with islands or scattered individual conifers, the tree cover has increased exponentially. This is especially prevalent in the Pine Savanna and dry site Douglas-fir/grassland habitats. This is largely due to the lack of frequent fire and fire suppression that would have killed conifer seedlings. Climate conditions prior to the 1980s would also have been conducive to the growth of conifers occupying grassland habitats.
- In mixed-severity regimes, shorter fire return intervals could convert lands to more of a low severity fire regime, as frequent fires promote more open stand conditions and species resistant to fire. Even in natural high-severity fire regimes, fire intensity and severity could be exacerbated in the short term due to the combination of drought and the dead fuels created by the recent mountain pine beetle outbreak. These influences could cause soil damage and reduction of regeneration potential where fires occur. Researchers have indicated high confidence that in the future Fire Regime I will shift towards decreased fire frequency and increased fire severity, Fire Regime III will have a shorter fire interval, and Fire Regime IV will experience increases in fire frequency but fire severity will remain unchanged (Rocca et al. 2014).
- Wildfire trends are interrelated with other drivers. Potential changes in the spatial heterogeneity of landscapes that result from changes in fire regimes may impact many ecosystem functions (Turner and others 2012). For example, forests impacted by insects experience changes in fuel distributions that alter the effects of fire, and conversely fires can alter the susceptibility of forests to insects and diseases. Wildfire is strongly influenced by landscape heterogeneity (e.g., the abundance and connectivity of fuel, and the presence of natural fire breaks and topographic variability) when fire weather is not extreme. Further, fire hazard depends, in part, on spatial patterns of human development and management activities. Vegetation management may decrease subsequent fire hazard under moderate burning conditions, depending on types and spatial patterns of treatment. A key element of ecosystem function and resilience is forest regeneration following wildfire. Spatial heterogeneity is important to forest regeneration in that the amount and configuration of undisturbed patches and individual legacy trees that survived prior disturbance will be important as seed sources for forest regeneration. Fires burning with high severity in forests adapted to low or mixed regimes can disrupt the regeneration mechanisms of plants, resulting in shifts in composition.

Fire and Fuel Management

Both the 1986 Custer forest plan and the 1987 Gallatin forest plan direction for fire management reflected national fire management policies in place at the time of publication. However, the Federal Wildland Fire Policy has evolved since then, recognizing fire’s roll in vegetation succession and as a key ecological disturbance process on the landscape. Even so, the threat of fire to values must have an appropriate response based on the risks to those values at the time of the event. The objective of fire management is to balance risks (e.g., personal safety and threats to values) and natural process for each fire.

In the summer of 1988, the Greater Yellowstone Area experienced an unprecedented fire season. Although wildland fire has been recognized as a key natural disturbance process that helped shape the landscape characteristics found throughout the Greater Yellowstone Area, a nationwide debate about fire management policy on Federal lands (specifically National Park Service and Forest Service policy) ensued. As a result of the 1988 Yellowstone fires, Congress mandated that the federal agencies coordinate all fire management operations within the Greater Yellowstone Area (Greater Yellowstone Area Interagency Fire Management Planning and Coordination Guide, 1990, rev. 2010), including planning and the ordering and sharing of resources for fire suppression, prescribed fire and other projects across multijurisdictional and geographic administrative boundaries of the Greater Yellowstone Area.

The Greater Yellowstone Area spans three states—Montana, Wyoming and Idaho—and includes portions of five national forests, two national parks, two national wildlife refuges and one national parkway and Bureau of Land Management lands (approximately 14 million federal acres). Coordinating partners include: Beaverhead-Deerlodge, Custer Gallatin, Shoshone, Caribou-Targhee and Bridger-Teton National Forests; Grand Teton and Yellowstone National Parks; Red Rocks Lakes Wildlife Refuge and the National Elk Refuge; John D. Rockefeller Jr. Memorial Parkway; and the Bureau of Land Management in Idaho, Montana and Wyoming. The fire organization is an active partner in this collaboration.

The Custer Gallatin annually manages approximately 93 percent of all natural ignitions with control, confine and point-protection strategies. The Custer Gallatin has managed naturally ignited fire as a natural process exclusively within the designated Absaroka-Beartooth Wilderness and the Lee Metcalf Wilderness since the early 1990s. Prior to the two national forest combining, the Gallatin Forest Plan Fire Management Amendment (2011) provided a forestwide standard: One or more fire management strategies may be considered and implemented for any unplanned wildland fire to achieve a variety of resource management objectives, while minimizing negative effects to life, investments and valuable resources.

Table 5 displays the acres of large fire (greater than 100 acres in size) that have occurred on the Custer Gallatin National Forest over the past 30 years (FIRESTAT records).

Table 5. Acreage of large wildland fires (>100 acre) burned since 1985 within the administrative boundaries of the Custer Gallatin NF, by decade and including all land ownership.

Landscape	1985-1994	1995-2004	2005-2015	All lands burned (percent)
Ashland	34,870	82,672	194,866	72%
Sioux	58,742	68,111	15,539	85%
Pryor Mountains	0	0	99	< 1%
Absaroka-Beartooth	649,463	34,310	157,785	70%
Madison-Henrys-Gallatin	330	47,127	15,302	7%
Bridger-Bangtails-Crazies	1113	1472	240	1%
Total Acres Affected by wildfire	744,518	233,692	380,831	**45%**

Forest plan direction found in the older 1986 and 1987 plans allow the use of prescribed fire (management-ignited) as a management tool to achieve the resource objectives as described for each management area. Along with prescribed burning, other management tools used for fuel management treatments include pre and commercial thinning, mastication, debris piling and burning, to name a few. The Custer Gallatin National Forest has used prescribed fire on the landscape for the past several decades. Objectives of treatments vary in accordance with forest plan and management area direction, and include reduction of forest fuels, site preparation following harvest, and improvement of wildlife habitat. Prescribed fire can influence vegetation conditions in a similar manner to wildland fires. Over the past 10 years, the Custer Gallatin has supported a hazardous fuel management program which treats 8,000 to 15,000 acres annually.

Wildland-urban Interface

The wildland-urban interface is the burnable area where wildlands and human development meet. Residences, commercial properties and infrastructure may be situated within, around or adjacent to burnable vegetation and may, themselves, be made of burnable material. Vegetation and fuel treatments are often focused in wildland-urban interface areas with the objective of reducing hazardous fuel conditions that may pose a threat to communities and other high valued resources, such as municipal watersheds. Also, treatments outside of the wildland-urban interface may be designed to alter landscape-scale fire behavior to change the type of wildfire that may burn into the wildland-urban interface. Therefore, an understanding of the extent and condition of wildland-urban interface areas is important to managers.

The whole of Custer Gallatin National Forest administrative lands lie in Gallatin, Park, Madison, Meagher, Sweet Grass, Stillwater, Carbon, Yellowstone, Rosebud, Powder River and Carter in Montana, and Harding County in South Dakota. All of these counties along with the States' Department of Natural Resources and Conservation developed Community Wildfire Protection Plans in the mid-2000s (see county community wildfire protection plans), which are evaluated annually and updated as wildland-urban interface areas expand. The community wildfire protection planning process identifies wildland-urban interface as areas of concern for wildland fires and assists in identifying and prioritizing areas for fuels treatment within the wildland-urban interface located within or near the Custer Gallatin National Forest administrative boundaries. The current trend in most of these counties on private land parcels is additional urban development (subdivisions, structures, new road accesses, utility corridors, and associated infrastructure). Therefore, this assessment report references the wildland-urban interface spatial data that can be found and requested on the individual counties websites.

Information Needs

A more current natural range of variation analysis is needed, comparing the fire modeling capabilities found in the SIMPPLLE model to those found in LANDFIRE datasets to refine the understanding of the role of fire, especially in regards to future trends with climate change conditions.

Key Findings

Trends:

- More extreme disturbance events (large fire) and higher inter annual climate variability can be predicted.
- Longer duration, large acreage unplanned fire events may become more common with anticipated warmer, drier climate change conditions and increase horizontal and vertical fuel accumulations.
- Typical fire season for South Central and Eastern Montana and the northwestern corner of South Dakota may extend 1-2 weeks earlier in the Spring months and 1-2 weeks later in the fall, than the typical fire seasons we have experienced.

Key Findings:

- Forest Plan direction regarding wildland fire management for the 1987 Gallatin NF Forest Plan document was updated and amended in 2011, allowing consideration of one or more management strategies for unplanned, naturally-caused fire to achieve a variety of management objectives on all NFS lands within the original Gallatin NF administrative boundary. Forest Plan direction regarding wildland fire management for the 1986 Custer NF Forest Plan document has not been updated since original FEIS/ROD, and relies on specific fire management guidance for designated wilderness vs. non-wilderness areas.
- Climate Change. The current plans do not explicitly consider how management guidance, emphases, and monitoring dovetail with various aspects of changing climate.
- Best available science. The current plans do not reflect best available science and policy related to wildland fire and prescribed fire.

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Glossary

fine fuels: Fast-drying dead or live fuels, generally characterized by a comparatively high surface area-to-volume ratio, which are less than1/4-inch in diameter and having a timelag of one hour or less. These fuel types (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry

fire regimes: A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee 1993; Brown 1995). It represents the periodicity and pattern of naturally occurring fires, described in terms of frequency, biological severity and aerial extent (Anderson 1982). Coarse-filter definitions for natural fire regimes were developed by Hardy and others (2001) and Schmidt and others (2002), and interpreted for fire and fuels management by Hann and Bunnell (2001). There are five natural fire regimes:

- I 0-35-year frequency and low severity (most commonly associated with surface fires) to mixed severity (in which less than 75 percent of the dominant overstory vegetation is replaced);
- II 0-35-year frequency and high severity (stand-replacing; greater than 75 percent of the dominant overstory vegetation replaced);
- III 35-100+ year frequency and mixed severity;
- IV 35-100+ year frequency and high severity (stand-replacing);
- V 200+ year frequency and high severity (stand replacing).

fire regime condition class (FRCC): measures the degree of departure from reference conditions, possibly resulting in changes to key ecosystem components, such as vegetation characteristics (species composition, structural stag, stand age, canopy closure and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances, such as insect and disease mortality, grazing and drought. The three fire regime condition classes are based on no or low (FRCC 1), moderate (FRCC 2, and high FRCC 3) departure from the central tendency of the reference conditions (Hann and Bunnell 2001; Hardy and others 2001; Schmidt and others 2002). They are described as follows:

> FRCC 1 – Fire regimes are within the natural or NRV and risk of losing key ecosystem components is low. Vegetation attributes (such as composition and structure) are intact and functioning, with a departure of less than 33 percent)
>
> FRCC2 – Fire regimes have been moderately altered. Risk of losing key ecosystem components is moderate. Fire frequencies may have departed by one or more return intervals, potentially resulting in moderate changes in fire and vegetation attributes. Departure my range between 33 - 66 percent.
>
> FRCC 3 – Fire regimes have been substantially altered, and risk of losing key ecosystem components is high. Fire frequencies may have departed by multiple return intervals, potentially resulting in dramatic changes in fire size, fire intensity and fire severity due to dramatic changes in vegetation and fuel condition characteristics (departure greater than 66 percent).

fire severity: describes the effect s of fire on the ecosystem, and is often expressed by the amount of vegetation replacement or effects to the soil.

fire-adapted species: plant species that have evolutionary adaptations to survive and thrive in an ecosystem where fire is a primary driver. These include tree species that are termed fire-tolerant, as well as trees and other plant species that have a myriad of other types of adaptations. Adaptations include serotinous cones of lodgepole pine (opening only when exposed to great heat in a fire); fast, early tree growth for rapid site domination; rhizomatous (below ground) root systems or root crowns; seeds with hard, fire resistant seed-coats; or very light, wind-spread seed.

fuel management: act or practice of managing or controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological or manual means, or by fire, in support of land management objectives.

fuel model: a set of surface fuel bead characteristics (fuel load and surface-to-area-to volume ration by size class, heat content and depth) organized for input into a fire model. Standard fuel models have been stylized to represent specific fuel conditions.

mixed-severity fire regime: mixed severity fire regime areas can experience the full range of fire intensity and severity, from non-lethal, low intensity fire to torching of individual or groups of trees. This type of fire disturbance results in variable vegetation patch sizes, creating an irregular pattern with an abundant amount of edge (Agee 1998; Arno et al. 2000).

stand-replacement, high severity fire: Any fire that causes greater than 75 percent top removal of a vegetation fuel type, resulting in general replacement of existing vegetation (Barrett et al. 2010). May or may not cause a lethal effect on the plants. For example, replacement fires in grassland removes the leaves, but leaves re-sprout from the basal crown of each plant, while replacement fire in most conifers causes mortality of the plant. Forest types conducive to stand replacing fire generally have continuous horizontal and vertical fuel structures (like a dense understory or interlocking tree crowns), which promote fire movement up into the overstory tree canopy. Tree mortality caused by insects and disease contributes to fuel accumulation. Unnaturally high woody fuel accumulation caused by wildfire suppression and overgrazing (lack of fine fuels) leads to longer return intervals, but larger and more severe fires, and a subsequent increase in patch size. The fire-adapted, shade-intolerant tree species in these ecosystems commonly live 140 to 400 or more years and maintain their dominance through reforestation strategies rather than individual tree resistance. For example, lodgepole pine, which is shorter lived and more vulnerable to fire injury, is well adapted to high intensity, high severity fire events because of its unique adaptive trait of producing serotinous cones. This adaptive trait allows living seed to be stored in serotinous cones on live or dead trees and in the soil that open under intense heat; temperatures generated with high intensity fire. This fire type characterizes fire regime II (the non-forested, grassland areas found in pine savanna landscapes and low elevation areas of the montane landscapes), and fire regime IV, which is one of the most common regimes found in the mid to high elevation montane landscapes found on the Custer Gallatin National Forest planning area.

surface or low-severity fire regime: non-lethal fire regime and of low intensity. These fire types are common in low elevation dry forest types and non-forested, grassland habitats, and rarely result in overstory tree mortality, minimal edge and patch size (Agee 1998; Arno et al. 2000; Hessburg et al. 2005). Low severity fire generally consumes litter, herbaceous fuels and foliage and small twigs with little heat traveling down through the duff (Fischer and Clayton 1983). Forest types that are considered “adapted” to frequent, low severity fire were often dominated by fire-resistant, early seral species.

Frequent fire maintained their dominance and promoted open-growing, sometimes uneven aged structures. These fires maintain grasslands and shrublands and the shifting distribution of limber pine and juniper. A low-severity ground fire in a stand of mature timber will reverse succession slightly by removing ground vegetation while maintaining large trees, while a stand-replacing fire greatly reverses succession by creating an early seral community dominated by herbaceous species. The historically treeless character of grassland and shrubland vegetation types was maintained by frequent wildfire. This type of fire would be common in fire regimes I and III, which are common in the Central and Eastern landscapes of the Custer Gallatin National Forest planning area.